Mapping India on Large Scales - A Quick and Viable Solution

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Abstract

For most of the mapping and engineering survey projects, the heights are still required above Mean Sea Level (MSL), whereas the heights given by Global Positioning System (GPS) are in terms of the WGS84 ellipsoid. The heights above MSL are called Orthometric Heights. Presently for India and many other countries, who have not yet established their own geoid, there is no method to convert the ellipsoidal heights to Orthometric heights. For such countries, the only way available to obtain Orthometric heights is through establishing a dense network of leveling lines that is very time consuming, cumbersome, and manpower- and cost-intensive. An alternative solution has been proposed that requires only a very few ground control points to be provided by GPS and a skeletal leveling network for large scale photogrammetric mapping without compromising accuracy. The concept has been validated with the aid of two test areas. It is shown that by adopting the proposed method, there is a significant reduction in the required number of GPS control points by more than 55 percent and the number of MSL height control points (as also the preprocessing/postpointing effort) by as much as 90 percent.

Introduction

India was one among the very few countries (including the advanced ones) to have completed topographic mapping on 1:50 000 and 1:25 000 scales, employing photogrammetric techniques, about four decades ago. Since then, there has been tremendous progress in the field of imaging and geomatics by way of the Global Positioning System (GPS), Inertial Measuring Units (IMUs), Large-Format High-Resolution Aerial Digital cameras, etc. Due to these developments, several countries have standardized the scales as large as 1:2500 and 1:1250 for country-wide topographic mapping and even larger scales ranging from 1:240 to 1:1200 for engineering applications mainly due to operability of GPS, IMU, and digital cameras which resulted in nearly complete automation for various photogrammetric processes, i.e., aerial triangulation, Digital Terrain Models (DTM), orthophoto generation, etc. The main advantage accrued due to these advancements is that there is a very little requirement of plan as well as vertical height ground control points (GCPs) for photogrammetric aerial triangulation (AT).

It is well established that with aerial imagery flown with GPS/IMU for photogrammetric applications, GCPs are required only at the corners of the photogrammetric block. Whereas, if aerial imagery is flown without GPS/IMU, full control points are required at close intervals along the periphery of the block, and height control points at much closer intervals in every flight line.

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The provision of control points along with ellipsoidal heights is an easy task, because these can expeditiously be established with the help of GPS. But height control points, also known as Bench Marks (BMs), are invariably required with heights above Mean Sea Level (MSL), and therefore, cannot be determined by GPS.

Specifically in countries such as India who have not yet established their own geoid, the only method available to determine the heights above MSL, known as Orthometric heights, is by precision leveling which is cumbersome, slow, costly, and error-prone. Some countries like the US and Canada have established their own precise geoid along with a correction surface and have made the solution available to the public for conversion of GPS (ellipsoidal) heights to Orthometric heights. The correction surface is generated from a sufficiently dense network of GPS control points and height BMs established by precise leveling.

The Geomatics Center Canada provides an on-line facility for direct transformation of NAD83 or ITRF ellipsoidal heights of any point in the Canadian Territory to CGVD28 Orthometric heights, (CSRS-A). The National Geodetic Survey (NOAA) of the US has released the GEOID96 (recently upgraded to GEOID12A) hybrid Height Model for Conversion of GPS Heights to NAVD88 Orthometric elevations (Milbert and Smith, 1996). Facilities are available online for interactive computation of Orthometric heights from GPS ellipsoidal heights, i.e., the NGS Geodetic Tool Kit. Because of these resources, these countries are able to take full advantage of the recent developments and carry out large-scale photogrammetric mapping most economically in a much smaller time-frame as compared to others who do not have such a capability.

India is one among such countries who have not yet established a precise geoid along with the required correction surface. As a result, though India has the capability of acquiring aerial imagery employing most-modern digital cameras equipped with GPS/IMU, the requirement of plan and height control points for photogrammetric surveys is the same as was obtaining during the analogue era. The net result is that photogrammetric mapping, even on scale as small as 1:10 000, is not viable due to its demanding time and cost implications.

An interim solution, especially for such countries, is proposed in this paper to make the large scale photogrammetric mapping viable which takes maximum possible advantage of the current advances in the field of Geomatics.

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